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A Structured Model for Designing and Evaluating Cross-Disciplinary Co-Creation Workshops

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Abstract

Cross-disciplinary co-creation workshops are increasingly used to address complex societal challenges; however, their design and evaluation often lack methodological rigour and transparency. This scientific work introduces a structured and transferable model for designing and evaluating cross-disciplinary co-creation workshops, grounded in a three-layer architecture: (i) preparatory and contextual elements, (ii) workshop design and execution, and (iii) evaluation and reflection. The model explicitly integrates logistical planning, participant selection, facilitation strategies, artefact generation, and systematic evaluation through a Goal–Method alignment framework, thereby strengthening the validity and reproducibility of workshop-based research. The model is demonstrated through a case study entitled 'A Co-creation Workshop on Circular Economy in the Irish Construction Sector'. The workshop brought together diverse stakeholders from academia, industry, and policy to collaboratively explore barriers, solutions, and digital toolkits supporting circular economy adoption. Multiple data sources, including artefacts, observations, and extensive recorded discussions, enabled triangulated analysis of both processes and outcomes. Findings highlight the importance of intentional participant selection, structured facilitation, and artefact-mediated interaction in transforming disciplinary diversity into productive collaboration. By positioning workshops as rigorous research instruments rather than informal engagement activities, this work contributes a practical yet theoretically grounded framework to support future cross-disciplinary co-creation initiatives.

Keywords: Co-creation Sessions, Traditional Information, Serious Games, Serious Play, Metaphor

1 Introduction

In recent years, we have faced an escalating array of complex societal and industrial challenges. Some of these challenges have emerged swiftly in unexpected arenas, such as AI and metaverse in education [1], while others reflect long-standing sustainability issues that remain unresolved, such as achieving full circularity using AI [2] in the construction sector [3]. Taken together, they underscore the imperative to re-examine how traditional scientific methods are applied in an increasingly dynamic and interconnected world.

The research landscape today is methodologically diverse, spanning interpretive and participatory approaches rooted in the social sciences to data-driven, algorithmic, and game-based techniques originating in computational disciplines. Unlocking the full potential of this rich methodology demands more than technical proficiency: it calls for a radical openness to crossing disciplinary boundaries and reimagining how knowledge is co-created and applied. There is a need to have a robust model for its implementation.

This paper advances action-oriented research [4] and interactive research [5] by introducing a structured, three-layer model for cross-disciplinary co-creation workshops that systematically integrates interpretive, participatory, and game-based approaches from the social sciences and computational disciplines. Rather than treating workshops as informal engagement events, the proposed model positions them as rigorous research instruments designed to generate actionable knowledge in complex societal contexts.

At its foundation, the *preparatory and contextual layer* ensures intentional participant selection, ethical integrity, and strategic alignment of objectives. This layer establishes the enabling conditions for meaningful cross-disciplinary exchange by carefully curating diverse yet thematically aligned stakeholders. The *workshop design and execution layer* combines highly interactive co-creation sessions with structured artefact generation (the creation of physical or digital entities, see Section 3 for details), alongside traditional expert keynote talks—similar to those featured at leading international conferences—and moderated panel discussions. This deliberate integration balances inspiration, structured knowledge input, and collaborative problem-solving, creating a dynamic environment where disciplinary boundaries are actively negotiated and new insights are collectively constructed. Finally, the *evaluation and reflection layer* embeds methodological rigour through the Goal-Method framework [6], explicitly aligning workshop objectives with evaluation strategies. This ensures transparency, triangulation, and analytical robustness, strengthening the validity and transferability of findings.

By combining these three interconnected layers, the model offers a systematic yet flexible platform capable of addressing complex industrial and societal challenges—such as the transition to a circular economy in the construction sector—with both creativity and methodological credibility.

The main contributions of this work are as follows:

1. A structured three-layer methodology for cross-disciplinary engagement. We introduce a novel framework that integrates preparatory strategy, interactive co-creation design, and systematic evaluation into a coherent architecture. The model combines interpretive, participatory, and game-based methods to enable deep cross-disciplinary collaboration. It was implemented in a focused thematic setting, bringing together researchers, practitioners, industry professionals, and policymakers from universities, companies, research centres, community organisations, and public sector bodies. This carefully curated diversity fostered rich, topic-specific exploration while ensuring coherence and productive dialogue.
2. Empirical validation through a real-world sustainability case. We demonstrate the applicability of the model through its deployment in a live sustainability-focused context. The workshop design was the result of intensive collaboration among researchers from computer science, anthropology, and sociology over more than three months, amounting to approximately 270 full-time working-days of preparation). This extensive groundwork enabled the thoughtful integration of disciplinary perspectives, facilitation techniques, and evaluation mechanisms, significantly enhancing the depth and analytical value of the outcomes.
3. Comprehensive and transferable design guidelines. We provide a detailed, step-by-step framework for designing impactful cross-disciplinary co-creation workshops. The guidelines operationalise the three-layer model, covering participant selection, facilitation strategies, artefact generation, session sequencing, and evaluation alignment. We also identify common organisational and methodological challenges and propose practical mitigation strategies. Together, these contributions offer a replicable and adaptable blueprint for researchers and practitioners seeking to design rigorous, inclusive, and action-oriented cross-disciplinary workshops.

The rest of this work is organised as follows. Section 2 discusses the theoretical framework used in this study. Section 3 provides the methodology employed. Section 4 discusses in detail the proposed model, whereas Section 5 puts into practice this model using a study case. Finally, discussion and key lessons learned are discussed in Section 6 and conclusions are discussed in Section 7.

2 Theoretical Framework

Workshops are widely used to carry out and disseminate research, serving as structured environments where diverse participants can exchange knowledge, explore emerging ideas, and collaboratively address complex challenges. They provide an effective mechanism for integrating multiple forms of expertise, fostering interdisciplinary dialogue, and generating actionable insights that can inform both academic inquiry and real-world decision-making.

2.1 Organising and Designing Workshops

General guidance on how to organise workshops has been proposed in the literature. For example, Pavelin et al. [7] outline ten practical rules for running interactive workshops, including (i) decide whether an interactive workshop is the right choice (e.g., when aims are unclear, running a workshop may not be advisable), (ii) choose participants carefully (e.g., aiming for diversity in experience, opinions, and interests), (iii) identify suitable activities (e.g., planning activities based on the desired outputs), (iv) identify facilitators and brief them (e.g., training independent coordinators), (v) consider logistics, facilities, and how to record outcomes (e.g., selecting suitable venues with adequate equipment), (vi) plan the agenda (e.g., balancing individual and collective tasks), (vii) market your interactive workshop as a network opportunity (e.g., positioning networking as an incentive for participation), (viii) get the best from your participants (e.g., creating a comfortable environment for participants), (ix) follow up with your facilitators and create a post-workshop report (e.g., gathering feedback from facilitators), and (x) follow up with your participants (e.g., collecting feedback from participants). These rules have served as foundations for organising other webinar series [8].

A related idea is presented by Sufi et al. [9], where the authors propose ten rules to measure the impact of workshops. Intuitively, this suggests that workshops can be designed and organised following these rules, depending on the type of workshop at hand. The authors discuss three types of workshops: (a) exploratory workshops, where ideas are analysed to better understand a topic, the problems faced, and potential solutions; (b) learning workshops, where a skill set, application, or technique is taught; and (c) creating workshops, where participants with a common interest attempt to solve a particular problem by collectively building a predefined object or entity, such as, software standards, resources or even papers.

The ten rules proposed by Sufi and colleagues are: (i) setting goals effectively (define outputs and outcomes), (ii) balancing time, effort, and costs (consider effort, time, and money in relation to impact), (iii) create metrics purposefully (metrics allow elements to be compared more easily), (iv) understand bias (be aware of confirmation bias, sampling bias, and social desirability bias), (v) design your surveys well (recognise the limitations of quantitative and qualitative questions), (vi) ask about participants' confidence (allowing participants' opinions to be "weighted"), (vii) ask about specific skills (enabling measurement of objectives for attendees), (viii) gather feedback before, during, and after the workshop, (ix) harness gamification to test participants' skills (assess whether participants have acquired skills), and (x) measuring those who did not attend.

Interactive and facilitated workshops have increasingly been recognised as structured arenas for collective knowledge production rather than merely venues for discussion. In this regard, Ellström et al. [5] position workshops within the broader tradition of interactive research, emphasising collaboration between researchers and practitioners as a core methodological principle. Interactive research is characterised by joint problem formulation, mutual learning, and iterative cycles of action and reflection. Within such settings, workshops function as boundary spaces where academic and practical knowledge intersect, enabling co-production of context-sensitive

insights. However, the authors also highlight challenges, including managing asymmetries of power, balancing scientific rigour with practical relevance, and ensuring that collaborative processes lead to sustained organisational learning rather than isolated events. These considerations are particularly salient in cross-disciplinary workshops, where differences in epistemologies, terminology, and institutional expectations must be carefully navigated.

Complementing this perspective, Tavella and Franco [10] explore the micro-dynamics of group knowledge production in facilitated modelling workshops. Their work demonstrates that knowledge does not simply emerge from assembling diverse participants; rather, it is actively constructed through structured interaction, facilitation techniques, and the use of modelling artefacts. Facilitation plays a critical role in shaping participation patterns, mediating conflict, and maintaining focus, while shared artefacts (e.g., visual models or diagrams) act as cognitive anchors that support negotiation of meaning. The authors show that group knowledge evolves iteratively, through cycles of divergence and convergence, suggesting that workshop design must intentionally create space for both exploratory dialogue and synthesis.

Taken together, these studies underscore that organising effective cross-disciplinary workshops requires more than logistical planning. It demands deliberate design of interaction formats, explicit facilitation strategies, and mechanisms for reflection and evaluation. Workshops become productive when they are treated as structured processes of collaborative inquiry—where diversity is channelled through guided interaction, and where learning is embedded within a broader research framework.

2.2 Evaluating Workshops

Workshops vary significantly accross disciplines, and often, their assessment lacks a rigours framework to evaluate them. For example, Rushmer et al. [11] evaluated eight workshops addressing priority public health issues in the United Kingdom. While the authors found that the workshops successfully generated enthusiasm and enabled meaningful, productive dialogue among participants, they also concluded that workshops alone were insufficient to prompt sustained changes in professional practice over the medium term. They also noted that the planned activities were almost never followed through. Whereas their findings were useful to understand what worked and what failed, the authors did not use any framework for evaluation. Although, it is worth noting that their study employed a rigorous mixed-methods approach, including 51 interviews, six observational sessions, and documentary analysis of workshop materials. The lack of using a robust framework for evaluation underscore the importance of embedding workshops within broader, methodologically grounded engagement and evaluation strategies.

Other studies evaluating workshops can be found in the specialised literature; however, these primarily focus on assessing participants rather than the workshop design itself. For example, Abdulghani et al. [12] employed Kirkpatricks' evaluation model [13, 14] to assess five research methodology workshops through measures of participants' satisfaction, knowledge and skill acquisition, and impact on practice. This evaluation model, originally developed for assessing training programmes, comprises four levels: the first level examines participants' perceptions of the training programme;

the second assesses knowledge acquisition; the third evaluates whether the acquired knowledge is transferred to the workplace; and the fourth focuses on broader organisational or project-level outcomes. While such approach provides valuable insights into participant learning and perceived impact, they offer limited support for systematically evaluating the design, structure, co-creation processes, and artefacts generated within cross-disciplinary workshops.

A relatively recent work by Thoring et al. [6] proposes a robust framework to evaluate workshops as research methods. They break it into three main areas, each with various elements. The first area focuses on general principles, including (i) focus definition (what exactly should be achieved through the workshop), (ii) role allocation (roles of stakeholders), (iii) triangulation (the use of various research methods), (iv) transparency (describing goals, evaluation methods, selection criteria, participant details, workshop process, and results), and (v) reflection (considering the usefulness of the evaluation procedure).

The second area focuses on evaluation goals, building on the work by Storvang et al. [15], and includes (i) the workshop goal (which can be a new artifact such as a product, document, service, process, or software), (ii) a previously designed artifact, and (iii) facilitation artifacts (e.g., tools and templates). Secondary aspects include (iv) the workshop procedure, agenda, and timing, (v) people's roles, (vi) dialogues, opinions, and interactions with the artefact, and (vii) the workshop's outcome.

The third and final area discusses various evaluation methods, including (i) observation and note-taking, (ii) photography, (iii) video recording, (iv) audio recording, (v) surveys and questionnaires, (vi) interviews, (vii) group discussions, and (viii) artefact analysis.

3 Methodology

In Section 2, we reviewed foundational works that articulate research principles for the design of workshops [7, 9], and we adopted these principles as a basis for structuring our workshop design. In addition, we drew on insights from interactive research and action research literature [5, 10], which emphasise participation, reflection, and iterative knowledge creation, and are particularly well suited to cross-disciplinary settings.

We then extended our literature review to examine workshop practices across a range of application domains, including health [11] and education [15]. This broader perspective provided empirical and practical insights into effective workshop structures, facilitation strategies, and common pitfalls. Synthesising evidence across domains enabled us to identify recurring patterns of what contributes to successful workshops, as well as practices that may hinder meaningful engagement or outcomes. Moreover, these works [11, 15], along with [6] have allowed us to present research on the evaluation of workshops.

Together, these strands of literature informed the formulation of core elements for designing cross-disciplinary workshops and fundamental elements for their systematic

evaluation. These elements provide a structured and evidence-informed foundation for both the design and assessment of co-creation workshops involving diverse stakeholders. The resulting methodology is presented in the following sections.

3.1 Methodology for designing the cross-disciplinary co-creation workshop

Table 1 maps the key rules and goals from the theoretical frameworks reviewed to the key design aspects developed in this work. It is important to note that the key design aspects are not intended to replace the state-of-the-art frameworks from Section 2 but rather to complement these works by enhancing our understanding of the most salient components of designing a workshop. Only the rules and goals from the three most relevant works have been reproduced in this table, but as aforementioned, we drew upon multiple additional academic works [5, 10, 11, 15].

The table can be read as follows: The model layer column groups the key design aspects under three robust categories: (i) preparatory and contextual elements; (ii) workshop design and execution; and (iii) evaluation and reflection. The next column highlights the Key Design Aspects developed in this work. Following on, we have the rules and goals from three of the theoretical frameworks.

The rules outlined by Pavelin et al. [7], Sufi et al. [9], and Thoring et al. [6] were broad enough to encapsulate many different parts of the design process. For example, "Setting goals effectively" (Rule i, from Sufi et al. [9]) has direct, actionable implications in the preparatory and contextual, design and execution, and evaluation and reflection phases.

From a workshop design perspective, Thoring et al. [6] was found to be both comprehensive and to have the strongest alignment with the key design aspects that were developed and refined in this work. While in their work, they broke down these rules into guiding principles, evaluation goals and evaluation methods, we instead propose a more holistic approach using interconnected layers to bridge these rules through the different design phases of a workshop, with a more direct focus on the fundamental aspects of the design process. A full explanation of these model layers is discussed in Section 4.

In Table 1, we highlight key design aspects that were identified and operationalised for this study. To ensure their appropriateness and coherence, we consulted domain experts from the Departments of Computer Science, Psychology, and Media Studies, as well as the Hamilton and Social Sciences Institutes. These experts included Associate Professors, Professors, and Full Professors. Feedback from these experts informed refinements to both the workshop structure and the co-creation activities, strengthening the alignment between design choices, participant expectations, and research objectives.

3.2 Methodology for evaluating the cross-disciplinary co-creation workshop

The evaluation of the cross-disciplinary co-creation workshop was guided by the Goal-Method framework [6], which provides a systematic approach for aligning evaluation

Model Layer	Key Design Aspects	Pavelin et al. [7]	Sufi et al. [9]	Thoring et al. [6]
Prep. & Cont.	Clearly defined overarching purpose and scope of the workshop	Rule i: Decide if interactive is right	Rule i: Setting goals effectively	Focus definition
	Identification and recruitment of targeted participants	Rule ii: Choose participants carefully	Rule vi: Ask about participants' 'confidence'	Transparency (selection criteria)
	Balanced cross-disciplinary representation	Rule ii: Choose participants carefully	N/A	Transparency (participant details)
	Structured participant grouping strategy	N/A	Rule vii: Ask about specific skills	People's roles
	Ethical approval and informed consent procedures	N/A	N/A	Transparency
	Appropriate venue selection (space, layout, accessibility)	Rule v: Consider logistics, facilities, and how to record outcomes	Rule ii: Balance time/effort/costs	N/A
	Materials prepared for interactive and co-creation activities	Rule iii: Identify suitable activities	N/A	Facilitation artifacts
	Recording strategy (audio, video, notes, artefact collection)	Rule v: Consider logistics, facilities, and how to record outcomes	Rule iii: Create metrics purposefully	Evaluation methods
Works. Des. & Exec.	Context and Primary Objectives	Rule vi: Plan the agenda	Rule i: Setting goals effectively	Workshop goal
	Logical sequencing of sessions (context → exploration → creation)	Rule vi: Plan the agenda	N/A	Transparency (workshop process)
	Balance between informational and interactive components	Rule i: Decide if interactive is right	N/A	Triangulation
	Clearly defined objectives for each session	N/A	Rule i: Setting goals effectively	Workshop procedure, agenda, and timing
	Well-designed co-creation activities (hands-on, artefact-oriented)	Rule iii: Identify suitable activities	Rule ix: Harness gamification	Triangulation
	Facilitation roles clearly allocated	Rule iv: Identify/brief facilitators	N/A	Role allocation
	Time management and agenda clarity	Rule vi: Plan the agenda	Rule ii: Balance time/effort/costs	Workshop procedure, agenda, and timing
	Integration of keynote/panel sessions as complementary elements	Rule vii: Market as network opportunity	N/A	N/A
	Mechanisms for documenting ideas and artefacts	Rule viii: Get best from participants	Rule i: Setting goals effectively	Dialogues, opinions, and interactions with the artefact
Eval. & Ref.	Explicit definition of evaluation goals	Rule ix: Follow up with facilitators/Post-workshop report	Rule i: Setting goals effectively	Evaluation goals
	Alignment between workshop goals and evaluation methods	N/A	Rule iii: Create metrics purposefully	Reflection
	Use of multiple data collection methods (triangulation)	N/A	Rule v: Design surveys well	Triangulation
	Assessment of both processes and outcomes	Rule ix: Follow up with facilitators/Post-workshop report	Rule i: Setting goals effectively	Workshop's outcome
	Collection of participant feedback (during and after)	Rule x: Follow up with participants	Rule viii: Gather feedback	Surveys and questionnaires
	Analysis of co-created artefacts	N/A	N/A	Artifact analysis
	Reflective assessment of design effectiveness	Rule ix: Follow up with facilitators/Post-workshop report	Rule iv: Understand bias	Reflection
	Identification of improvements for future iterations	Rule ix: Follow up with facilitators/Post-workshop report	Rule x: Measuring non-attendees	Reflection

Table 1: Key design dimensions of the co-creation workshop and their systematic alignment with the proposed three-layer model, demonstrating how each strategic decision is anchored in a coherent and rigorous methodological architecture.

goals with appropriate data collection methods. This framework enabled the assessment of both process-oriented aspects (e.g., participant interactions and behaviours) and outcome-oriented aspects (e.g., quality of artefacts and ideas generated). Table 5 reproduces this framework from Thoring et al. [6]. We deliberately present this table in

Section 5.3 as a structured instrument for critically assessing the robustness, coherence, and practical applicability of our proposed three-layer model.

Evaluation goals (Table 5, first column) were defined in advance of the workshop and covered both primary and secondary dimensions, including the generated artefacts, participants' behaviours, dialogue, interactions, perceptions and ideas, opinions and ideas, as well as organisational aspects such as agenda and timing, space, materials, and the quality of workshop outcomes. To address these goals with methodological rigour, multiple complementary evaluation methods were employed, including observation and note-taking, photography, audio recording, surveys and questionnaires, group discussions, and artefact analysis (Table 5, column headers). The use of multiple methods supported triangulation and enhanced the validity of the findings.

Ethical considerations were integral to the evaluation methodology, despite not often being explicitly discussed in the literature [6, 7, 9] (see Table 1). All data collection activities were conducted in accordance with the approved research ethics protocol, and informed consent was obtained from all participants prior to data recording. The collected data were subsequently analysed by mapping evaluation goals to evaluation methods, enabling a transparent assessment of how workshop design choices and activities contributed to the observed outcomes. This evaluation methodology ensures that the findings reported in this study are both systematically grounded and reproducible in similar cross-disciplinary workshop contexts.

4 A Model for Designing and Evaluating Cross-disciplinary Co-creation Workshops

This paper proposes a structured model for the design and evaluation of cross-disciplinary co-creation workshops. The model synthesises insights from prior literature on workshop design, participatory and action research, and systematic evaluation frameworks, and integrates them into a coherent and reusable approach. Its primary purpose is to support researchers and practitioners in planning, executing, and evaluating workshops that bring together diverse stakeholders, while maintaining methodological rigour and transparency.

The proposed model is deliberately generic and adaptable. It is intended to be applicable across domains and contexts, while being sufficiently structured to guide concrete design and evaluation decisions.

4.1 Overview of the Model

At a high level, the model consists of three interconnected layers: (i) preparatory and contextual elements, (ii) workshop design and execution, and (iii) evaluation and reflection. These layers are not strictly sequential; rather, they form an iterative process in which insights from evaluation can inform future workshop design and refinement.

The model explicitly links design decisions to evaluation goals, ensuring that workshop activities are not only engaging but also empirically assessable. This alignment is particularly important in cross-disciplinary settings, where differences in language, priorities, and expectations can otherwise undermine both collaboration and evaluation. Table 2 gives an overview of these layers along with their key elements. The

table rows have been colour coded based on the evaluation goals defined by Thoring et al. [6], demonstrating the interconnectedness of the design aspects across all three model layers. A checklist column has been added to aid other academics and workshop organisers if they wish to use this table for designing there own workshops. In the following sections, we discuss it in detail.

Table 2: Model layers and key design aspects for cross-disciplinary co-creation workshops.

Model Layer	Key Design Aspects	x
Prep. & Cont.	Clearly defined overarching purpose and scope of the workshop	☐
	Identification and recruitment of targeted participants	☐
	Balanced cross-disciplinary representation	☐
	Structured participant grouping strategy	☐
	Ethical approval and informed consent procedures	☐
	Appropriate venue selection (space, layout, accessibility)	☐
	Materials prepared for interactive and co-creation activities	☐
	Recording strategy (audio, video, notes, artefact collection)	☐
Works. Des. & Exec.	Context and Primary Objectives	☐
	Logical sequencing of sessions (context → exploration → creation)	☐
	Balance between informational and interactive components	☐
	Clearly defined objectives for each session	☐
	Well-designed co-creation activities (hands-on, artefact-oriented)	☐
	Facilitation roles clearly allocated	☐
	Time management and agenda clarity	☐
	Integration of keynote/panel sessions as complementary elements	☐
	Mechanisms for documenting ideas and artefacts	☐
Eval. & Ref.	Explicit definition of evaluation goals	☐
	Alignment between workshop goals and evaluation methods	☐
	Use of multiple data collection methods (triangulation)	☐
	Assessment of both processes and outcomes	☐
	Collection of participant feedback (during and after)	☐
	Analysis of co-created artefacts	☐
	Reflective assessment of design effectiveness	☐
	Identification of improvements for future iterations	☐

Workshop Goals | Introduced Artifacts | Facilitation Artifacts
Procedure | People's Roles/Actions | Workshop Outcomes

4.2 Preparatory and Contextual Layer

The preparatory layer captures the foundational elements required before a workshop takes place. This includes defining the overarching purpose and scope of the workshop,

identifying and recruiting targeted participants, and ensuring appropriate ethical and logistical arrangements. Particular emphasis is placed on participant selection and grouping, as cross-disciplinary co-creation benefits from both diversity of perspectives and structured opportunities for focused interaction.

This layer also encompasses practical considerations such as venue selection, materials, and recording devices, which directly affect the feasibility of interactive activities and the quality of data collected for evaluation. By explicitly incorporating these elements into the model, we recognise their role as enabling conditions rather than peripheral concerns.

4.3 Workshop Design and Execution Layer

The second layer of the model focuses on the internal structure of the workshop. This includes the sequencing of sessions, the balance between informational and interactive components, and the design of co-creation activities. The model supports a progression from shared understanding to collaborative exploration and solution development, allowing participants to build common ground before engaging in more generative tasks.

Within this layer, co-creation sessions play a central role. These sessions are designed as hands-on, highly interactive activities supported by carefully chosen materials, enabling participants to externalise ideas, negotiate meanings, and collaboratively construct artefacts. Standard workshop elements, such as keynote talks or panel discussions, are integrated as complementary components that provide context, inspiration, and expert perspectives without dominating the co-creation process.

4.4 Evaluation and Reflection Layer

The third layer of the model addresses the systematic evaluation of both workshop processes and outcomes. Drawing on the Goal-Method framework [6], this layer requires the explicit definition of evaluation goals and the selection of appropriate evaluation methods. By employing multiple, complementary methods, the model supports triangulation and enhances the robustness of findings.

Evaluation is treated not as a post-hoc activity, but as an integral component of the workshop model. Data collected during and after the workshop feed into reflective analysis, enabling researchers to assess the effectiveness of design choices, the quality of outcomes, and the nature of cross-disciplinary engagement. These reflections can then inform subsequent iterations of the workshop or adaptations of the model to new contexts.

4.5 Positioning of the Use Case

The model described above provides a conceptual and methodological foundation for designing and evaluating cross-disciplinary co-creation workshops. In the following section, we instantiate this model through a concrete use case: a co-creation workshop on the circular economy in the Irish construction sector. This use case demonstrates

how the model can be operationalised in practice, illustrating design decisions, evaluation strategies, and lessons learned, while highlighting the model's flexibility and applicability to real-world, cross-disciplinary challenges.

5 A Co-creation Workshop on Circular Economy in the Irish Construction Sector: A Case Study

5.1 Preparatory and Contextual Layer

To ensure the successful execution of the in-person workshop, several key elements were required, including overarching purpose and scope of the workshop, an appropriate venue, workshop materials, recording devices, to mention a few (see Table 2 for details). Each of these elements is discussed in detail in the following sections.

5.1.1 Overarching Purpose and Scope of the Workshop

The overarching purpose of the workshop is to deliberately stimulate the exchange and integration of ideas among participants drawn from diverse organisations and disciplinary backgrounds, all sharing a common thematic focus. Rather than relying on unstructured dialogue, the workshop is designed to systematically elicit, surface, and synthesise distributed knowledge through carefully planned and purpose-driven activities.

By creating a structured yet open environment, the workshop aims to transform individual expertise into collective intelligence. This involves not only encouraging discussion, but also intentionally designing mechanisms that enable participants to externalise their perspectives, challenge assumptions, and collaboratively construct new insights. In this sense, the scope of the workshop extends beyond knowledge sharing; it seeks to foster meaningful cross-disciplinary engagement that generates actionable outcomes grounded in both research and practice.

5.1.2 Identification of Targeted Participants

To ensure strong alignment with the Environmental Protection Agency (EPA)-funded "The CirculaR Economy Buildings as Material Banks" (REBUILD) project's objectives (these are discussed in Section 5.2.1), we conducted a thorough stakeholder mapping exercise focused on identifying individuals whose work and interests intersect with circularity in the construction sector. This process drew on publicly available information, insights gathered from attending a wide range of events, including conferences, webinars, and seminars, as well as trusted referrals from colleagues and collaborators. We also reviewed relevant research publications, policy documents and similar, to identify additional potential participants whose expertise could enrich the discussion (details on this can be found in our recent review article [3]).

We contacted approximately 150 carefully selected individuals via email. Five of these requested an informal online or telephone discussion. From the total invitees, 50 registered for the workshop, with over 40 ultimately attending on the day, including all individuals who had requested an initial discussion.

5.1.3 Balanced Cross-disciplinary Representation

This targeted outreach enabled us to successfully convene a diverse and engaged group of stakeholders, including architects, surveyors, academics, policymakers, and professionals from across the construction sector. We ensured a balanced representation of attendees across these sectors, enabling us to group them according to their professional backgrounds (as discussed in detail in the following section).

We also ensured institutional diversity by bringing together participants from universities, research centres, industry, and non-governmental organisations, creating a truly multidisciplinary environment for collaboration and co-creation.

5.1.4 Structured Participant Grouping Strategy

In order to fulfil the objectives of the EPA-funded REBUILD project (see Section 5.2.1), we sought to leverage the collective knowledge of all participants during our one-day workshop, which was attended by over 40 individuals from diverse areas and institutions, all sharing an interest in the same topic (details are provided in Sections 5.1.2 and 5.1.3).

To maximise the insights gained from the workshop, attendees were carefully grouped according to their professional backgrounds to facilitate a comprehensive understanding of circular economy in the construction sector in Ireland. Six groups were formed, each with approximately equal numbers of participants. During each of the three main co-creation sessions (discussed in Section 5.2), initial interactions occurred exclusively within each group, with cross-pollination of ideas taking place later within the same sessions.

5.1.5 Ethical Approval and Informed Consent Procedures

As outlined in Section 5.1.2, the workshop attracted over 40 participants, all with an interest in the circular economy within the construction sector in Ireland. The workshop comprised multiple sessions, including participant-led discussions on key aspects of the REBUILD project, expert contributions, a keynote address, and discussions with stakeholders working on circular economy initiatives. The workshop lasted six hours (just below five hours excluding breaks) resulting in a rich and diverse source of empirical data.

To complement the insights, solutions, and challenges related to the circular economy in the Irish construction sector that emerged from the workshop activities (see Section 5.2), we audio-recorded all discussions and presentations, amounting to approximately five hours of recorded material per table.

To support this data collection, a research ethics application was submitted to the University Research Ethics Committee for review and approval. The process took approximately five weeks from submission to approval and involved two rounds of feedback. As a result, an information sheet and consent form were prepared for participants. These documents were distributed two weeks prior to the workshop, and all participants provided informed consent either before or on the day of the workshop.

5.1.6 Appropriate Venue Selection

The workshop was highly interactive, requiring participants to engage continuously with one another. Its design also necessitated that participants document their ideas using paper and post-it notes. The workshop was held in a venue equipped with ten round tables, using six of them, comfortably accommodating between six and eight swivel/castored chairs in each of these tables.

As participants were required to share their findings, ideas, and proposed solutions, and given the inclusion of keynote speakers, panel discussions, and presentations of related projects w.r.t. the workshop (described in Section 5.2), it was essential to ensure appropriate technical infrastructure. This included computer and projector setups (two were available, with one serving as a backup), a desk-based microphone, and multiple mobile microphones and speakers distributed throughout the venue.

5.1.7 Material for Co-creation Activities & Recording Devices

The workshop (see Section 5.2 for details) comprised three co-creation sessions, each featuring three hands-on, highly interactive activities. Together, these nine activities were carefully supported by well-designed materials, which not only generated rich written insights from participants but also enabled the capture of implicit findings emerging through interaction, behaviour, and collaborative sense-making.

We systematically recorded all table discussions to ensure a comprehensive and reliable capture of the co-creation process. Each table was equipped with two audio recording devices, one serving as a dedicated backup to mitigate the risk of data loss. To guarantee uninterrupted documentation, we brought sufficient spare batteries and proactively replaced them midway through the workshop. Each device was tested fully prior to the workshop, to ensure audio levels were consistent and set correctly, audio formats were consistent across devices, each device had sufficient memory for the duration of the workshop, and to ensure each device was functioning as intended. This strategy ensured continuous, high-quality recording of conversations throughout the entire event.

Table 3 presents the materials and equipment used in the workshop, organised by functional category. This categorisation highlights how resources supported participant interaction, data collection, workshop logistics, and presentation delivery.

5.2 Workshop Design & Execution

5.2.1 Project Context and Primary Objectives

We successfully implemented this crossdisciplinary workshop model as part of our EPA-funded REBUILD project. This initiative tackles persistent challenges around circularity in the construction sector in Ireland. The main objectives of the REBUILD are:

1. Deliver state-of-the-art reviews of best operations, practices and adoptions in the construction sector to enable dynamic and flexible evolution of buildings in Ireland leading to a smart circular economy

Table 3: Categorised workshop materials and equipment.

Category	Item	Quantity	Purpose
Participant interaction	Yellow post-it notes	8	Categorisation
	Pink post-it notes	8	Categorisation
	Highlighters	8	Emphasising key points
	Blue markers	8	Facts we know
	Red markers	8	Barriers contexts
	Green markers	8	Enablers contexts
	Black markers	8	General notes
	Erasers	8	Corrections
	A1 pad (30 sheets)	1	Capturing participants' ideas
	A4 pack (200 sheets)	1	Capturing participants' ideas
Data collection	Audio recorders	12	Recording conversations
	AA batteries	6	Powering recorders
	AAA batteries	20	Powering recorders
	Consent forms	50	Permission for audio recording
	List of attendees	1	Attendance tracking
Logistics and note-taking	Badges	50	Name tags
	Biros	48	Note-taking
	Notepads	8	Note-taking
	Wipes	1	Cleaning tables
Presentation and dissemination	Computer	1	Presentation delivery
	Charger	1	Power supply
	HDMI connector	1	Display connection
	USB storage device	1	Storing presentation slides
	Remote control	1	Presentation delivery

2. Identify barriers and enablers in the Irish construction industry to move from a linear economy to a truly circular economy, and
3. Design, implement and evaluate a toolkit that simulates the use of multiple building materials to see their economic and carbon emissions impact.

Based on these key objectives, the REBUILD project deliverables include reports detailing project milestones, white papers, and academic journals addressing circular economy barriers and enablers in construction. Furthermore, the project focuses on developing a toolkit for material comparison and carbon emission trade-off analysis, alongside communications to disseminate research findings. To ensure alignment with these core principles, we formatted an agenda that directly reflects these outputs and the project's primary goals.

The workshop agenda comprised a Welcome Session, a Content and Concept Session, three Co-creation Sessions, a Keynote Speaker Session, an EPA-funded Speaker Session, a Panel Discussion, and two breaks. An overview of the agenda is provided in Table 4. Next, we discuss in detail each of the main sessions of the workshop.

5.2.2 Welcome and Introduction to Content and Concepts

We dedicated the opening 20 minutes to setting the stage for the workshop. The first part of the workshop, *Welcome*, focused on introducing and greeting the attendees,

Table 4: Overall Structure of the 1st Workshop on Circular Economy in the Construction Sector in Ireland.

Time	Programme Activity
9:35 AM – 10:00 AM	**Registration & Networking**
10:00 AM – 10:10 AM	**Welcome** *Welcome Remarks:* Overview of workshop objectives, goals, and expected outcomes. *Introduction to REBUILD Project:* Brief introduction to the REBUILD project.
10:10 AM – 10:20 AM	**Introduction to Content and Concepts**
10:20 AM – 11:40 AM	**Co-creation Session 1: Elements of Circular Economy in the Construction Sector** Identify key principles and components of circular economy. Explore main enablers and barriers from the perspectives of policymakers, industry professionals, architects, and others.
11:40 AM – 12:00 PM	**Tea/Coffee/Rest Break**
12:00 PM – 1:10 PM	**Co-creation Session 2: Imagining Solutions for Barriers** Develop innovative and actionable solutions to overcome the key barriers identified in Session 1.
1:10 PM – 2:00 PM	**Lunch & Networking**
2:00 PM – 2:20 PM	**Keynote Session: Circular Economy in Construction – Challenges and Opportunities** *Speaker: Warren Phelan* An EPA perspective on circular economy practices in Ireland's construction sector.
2:20 PM – 2:35 PM	**EPA-Funded Projects on Circular Economy** *Presenters:* Dr. Liam Heaphy, Dr. Jack McCarthy, Dr. Mark Kelly
2:35 PM – 3:25 PM	**Co-creation Session 3: Digital Toolkits for Circular Economy in Construction** Co-design potential digital tools to support circularity, enabling data-driven insights on materials' cost and carbon impact.
3:25 PM – 3:55 PM	**Panel Discussion: Lessons Learned and Failures in Circular Economy Implementation** *Panellists:* Donal O'Donohue, Ruth Saurin, Cian O'Hora, Warren Phelan, Philippa King
3:55 PM – 4:00 PM	**Closing Remarks & Next Steps** Summary of key takeaways. Outline of REBUILD project's next phases and participant involvement.

introducing the main organisers of the event (the authors of this work) and highlighting their research experience, outlining the steps taken to deliver a high-quality and engaging workshop, and presenting the main objectives of the workshop. This introduction was complemented by presenting our invited speakers and reviewing the agenda, which had been shared with attendees six weeks prior to the event.

The second part of this session, *Introduction to Content and Concepts*, introduced the core content and foundational concepts underpinning the workshop. This was a

fundamental part of this session that allowed us to to clearly explain to the stakeholder the value of the co-creation sessions. We wanted to make sure that they understood the adoption of serious games [16] and serious play [9] in these sessions. We also introduced why and how the use of metaphors was important for the success of working on pressing problems in each of the co-creation sessions.

5.2.3 Co-creation Session 1: Elements of Circular Economy in the Construction Sector

This co-creation session, "Elements of Circular Economy in the Construction Sector", directly addressed one of the core objectives of the REBUILD project: identifying the key barriers and enablers involved in transitioning the construction sector from a traditional linear economy to a more dynamic and resilient circular economy.

The rationale for this session was to create a structured space in which participants could collectively surface, analyse, and prioritise the factors that either hinder or facilitate this transition. By drawing on the diverse expertise present in the room, the session aimed to generate an evidence-informed understanding of the systemic, organisational, regulatory, and cultural dimensions shaping circular economy adoption within the Irish construction sector.

The session unfolded through three carefully structured activities designed to build collective understanding and insight. The *first activity* focused on mapping the components of the construction ecosystem. Working in groups, participants identified the fundamental elements of the construction domain, such as stakeholders, processes, and materials. Each participant wrote their elements on yellow post-it notes. These were then arranged collaboratively on a large A1 sheet, serving as a shared visual representation of their knowledge. Groups also selected a spokesperson to present in the next activity. This stage lasted 15 minutes and served as the foundation for the discussion that followed.

The *second activity* focused on cross-group knowledge exchange. Each group presented its ecosystem map to all participants, with one member displaying the A1 sheet while another summarised the group's key insights. This process enabled participants from other groups to compare perspectives and contribute additional elements that may have been overlooked. When such contributions arose, the newly identified element was recorded on a pink post-it note and added to the corresponding A1 sheet, thereby enriching the overall collective understanding by contrasting or complementing the observations from the first activity (yellow post-it). Each group had precisely three minutes and 30 seconds to present, with the full activity lasting 30 minutes. This collaborative exchange was instrumental in building a more complete and nuanced understanding of the construction ecosystem.

The *third activity* focused on identifying the main barriers and enablers for circularity in the construction sector. Participants returned to their A1 sheets and, using the previously identified elements, annotated each with corresponding challenges and opportunities that either hinder or support circular practices. This exercise promoted focused discussion on systemic obstacles and actionable levers for change. The final activity lasted 20 minutes and concluded the session with a tangible set of insights that would inform the next stages of the workshop.

Together, these three activities created a participatory environment that combined systems thinking with grounded sectoral expertise, laying the groundwork for deeper problem-solving in the sessions that followed.

5.2.4 Co-creation Session 2: Imagining Solutions for Barriers

After a 20-minute break, we started the second co-creation session, "Imagining Solutions for Barriers", a pivotal component of the workshop designed to envision both individual and collective solutions to the barriers hindering the construction sector's transition toward circular economy practices.

The rationale for this second session was to build on the insights developed earlier in the day by guiding participants through a structured process that encouraged critical reflection, prioritisation of challenges, and the formulation of actionable strategies to support the transition toward a circular construction ecosystem.

This second co-creation session consisted of three well-defined activities. The *first activity* consisted of two tightly structured tasks. First, each group revisited their findings from the earlier session and identified the ten most pressing barriers to adopting circular economy practices (this was the last activity from the first co-creation session). These were documented on an A4 sheet and ranked in order of importance, with the first representing the highest priority and the last the lowest. A focused group effort completed this in six minutes. Immediately after, the session shifted to an individual task: each participant generated eight innovative solutions to tackle their group's top-ranked barrier. This personal reflection encouraged creative thinking and ensured a diversity of ideas. The individual task took eigh minutes, completing the activity in 15 minutes total. Thus, for a group of six people, 48 solutions were generated for the most pressing barrier. Thus, across the six groups participating in the workshop, more than 288 solutions were generated (some table had six to eight people), thereby helping to maximise the number of solutions.

The second activity brought the group together again to synthesise their best ideas. On a fresh large A1 sheet, each team documented their top eight solutions for the most critical barrier identified, along with the construction ecosystem elements most affected by this barrier. Groups were encouraged to discuss and justify their selections, and they also nominated a spokesperson to present their findings. This collaborative activity took 15 minutes.

The *third activity* from the second co-creation session of this workshop gave space for cross-group learning and knowledge sharing. Each group had three minutes and 30 seconds to present their insights to the wider audience. Two participants stood at the front, one displaying the A1 sheet and the other explaining: (1) the most important barrier, (2) the affected element(s) in the construction system by this barrier, and (3) the rationale behind their selected solutions. This final activity reinforced the collective intelligence generated throughout the session and allowed participants to reflect on overlapping challenges and novel strategies emerging across the groups.

5.2.5 Co-creation Session 3: Digital Toolkits for Circular Economy in the Construction

Our final co-creation session, "Digital Toolkits for Circular Economy in the Construction Sector", was strategically designed to address a critical challenge: how to simulate the substitution of one construction material for another and assess the resulting implications in terms of cost and carbon emissions.

This session tackled two core objectives: (a) understanding how digital tools can support material substitution decisions, and (b) defining the essential features a toolkit must have to be effective in advancing circular construction practices.

The session unfolded in two dynamic activities. In the *first activity*, we invited stakeholders to address the guiding question: how can we begin to estimate cost and carbon emissions when replacing one material with another? To support discussion, two prompts were introduced: (a) which digital toolkits do you currently use or are familiar with for this purpose?, and/or (b) what key features should a toolkit include to effectively serve this need?

Participants had 15 minutes to explore these prompts within their groups, selecting and justifying a relevant case study, such as constructing a new house or retrofitting a house (apartment, building, etc). To ground the discussion, we presented an illustrative scenario: a new regulation requires the mandatory use of a toolkit to estimate cost and emissions for all new home constructions in Ireland.

Each group explored one of two scenarios. Scenario A: For stakeholders familiar with existing toolkits, the focus was on identifying tools they already use or trust, and evaluating whether these could be adapted or extended (e.g., if open-source) to meet REBUILD's objectives (see Section 5.2.1). Scenario B: For those without experience using such tools, the task was to imagine the ideal toolkit, detailing the features it should have and explaining why these would be critical for success. Each group synthesised their ideas and insights on a new large A1 sheet, and nominated one member to present their findings in the next activity.

The second activity was dedicated to knowledge sharing and cross-pollination of ideas. Each group presented their selected use case, clearly explaining why it was chosen, and shared their insights on digital toolkits. Groups that explored Scenario A highlighted existing tools they regularly use and recommended how these could support material substitution and carbon-cost analysis. Those working on Scenario B outlined essential features a new toolkit should offer, emphasising how these capabilities would meet the session's dual objectives: simulating material substitution and evaluating its economic and environmental impact.

Each group had a maximum of three minutes and 30 seconds to deliver their findings, creating a fast-paced, insightful exchange of practical ideas and innovative perspectives.

5.2.6 Standard Sessions: Keynote Address, EPA-funded Projects, and Expert Panel Discussion

The three co-creation sessions described before allowed us to guide over 40 attendees with various backgrounds and expertise (details of this are presented in Sections 5.1.2

and 5.1.3), with the same interest in the topic (circular economy in the construction sector in Ireland).

We complemented the co-creation activities with a series of standard sessions. The first of these was a keynote address delivered by a senior representative of the Environmental Protection Agency (EPA) in Ireland. This is an independent public body established in Ireland in 1992 to protect, improve, and restore environment through regulation, scientific monitoring and enforcement. The keynote provided participants with a clear and authoritative overview of the EPA's strategic priorities, ongoing initiatives, and emerging pathways for accelerating circularity at national level. This session not only grounded the workshop in current policy realities, but also helped align participants around the broader systemic context in which their work and insights would contribute. Feedback indicated that the session was highly informative.

The second session focused on EPA-funded projects related to the circular economy across a range of thematic areas. This was a highly informative segment designed with two key objectives: (a) to increase participants' awareness of the priority domains and strategic interests of the EPA, and (b) to share insights and emerging findings from ongoing circular economy initiatives across different sectors in Ireland. The session was facilitated by three experienced researchers who brought diverse perspectives and deep subject-matter expertise. Participants responded very positively, noting the value of understanding both the breadth of EPA-supported work and the tangible progress being made in circular economy domains.

The third and final standard session was an expert panel discussion featuring five specialists with deep interest and experience in the themes explored throughout the workshop. The panel brought together a broad range of perspectives, including representatives from regulatory bodies, property development firms, environmental service companies, and academia. Guided by carefully crafted questions, the session began by inviting panellists to reflect on key elements required to initiate or accelerate the adoption of circular economy practices within the construction sector. This set the stage for a rich and dynamic exchange, after which the discussion was opened to the wider audience. The session was exceptionally well-received, generating active engagement from participants across all tables, many of whom contributed questions, insights, and reflections that further enriched the conversation.

5.2.7 Closing Remarks & Next Steps

Before the attendees departed, we provided a concise summary of all activities undertaken throughout the workshop, along with an overview of the data that will be analysed in the coming months to advance the objectives of the project (see Section 5.2.1). The closing session also addressed two important elements.

First, we outlined the pathways for continued collaboration, including opportunities for participants to contribute to follow-up consultations, co-design sessions, and ongoing validation of project outputs.

Second, we gathered structured feedback from participants to help us assess the effectiveness of the workshop and identify areas for enhancement in future iterations. This feedback is essential for ensuring that subsequent workshops remain engaging, inclusive, and aligned with the needs and expectations of our stakeholders.

5.3 Evaluation and Reflection Layer

We now evaluate the proposed workshop using the well-established and robust Goal-Method framework introduced by [6], previously described in Section 2.2. This framework provides a systematic and transparent basis for assessing both the breadth of evaluation goals addressed and the methodological rigour underpinning the study.

The primary evaluation goals of our workshop are twofold: (1) the produced artefacts and (2) the quality of the workshop outcomes. Beyond these, a comprehensive set of secondary evaluation goals is considered, including (3) participants' behaviours during the workshop, (4) participants' dialogue, (5) participants' interactions, (6) participants' perceptions and feelings, (7) participants' opinions and ideas, (8) the workshop agenda and timing, (9) workshop equipment, furniture, and spatial arrangement, and (10) workshop materials, tools, and templates.

To ensure a high level of research rigour, we employed a diverse set of complementary evaluation methods, namely: (i) observation and note-taking, (ii) photography, (iii) audio recording, (iv) surveys and questionnaires, (v) group discussions, and (vi) artefact analysis. The use of multiple methods supports methodological triangulation, strengthening the validity and credibility of the findings.

In the use case presented in Section 5.2, six of the eight evaluation methods defined in the Goal-Method framework [6] are applied. Interviews and video recording were not used in this case study, as they were not required to address the specific goals of the REBUILD use case (see Section 5.2.1). Nevertheless, it is important to note that the proposed methodology for cross-disciplinary engagement is sufficiently flexible and extensible to accommodate all evaluation methods within the framework, should different workshop goals or contexts require them.

Importantly, our methodology compares favourably with existing studies evaluated using the same framework. As reported in [6], approximately half of the reviewed studies address three or fewer evaluation goals, and some rely on a single evaluation method, thereby limiting opportunities for triangulation. While a subset of studies employs multiple methods, only a small number make use of four or five. In contrast, our approach addresses a broad set of evaluation goals and employs six distinct evaluation methods, placing it among the most comprehensive and methodologically rigorous applications of the Goal-Method framework.

To complement this discussion, Table 5 provides a concise visual synthesis of the evaluation framework and its instantiation in our study. The left-hand side of the table lists the evaluation goals, ranging from *Introduced Product, Process (Artefact)* to *Workshop Outcome Quality (e.g., ideas, strategy)*. The central portion of Table 5 presents the eight evaluation methods defined in the framework, spanning from *Observation and Notes* to *Artefact Analysis*. For each evaluation method, two columns are reported: *Suitability*, indicating the applicability of the method to a given evaluation goal, and *Adopted*, indicating whether the method was applied in the context of our workshop. All elements of the table, with the exception of the *Adopted* column, are derived directly from the Goal-Method framework proposed by [6]. The *Adopted* column is used to make explicit how evaluation goals were operationalised through specific evaluation methods in our case study.

Table 5: Goal-Method framework for workshops. Table adapted from [6].

Evaluation Goal	Evaluation Methods															
	Observation & Notes		Photography		Video Recording		Audio Recording		Survey & Questionnaire		Interview		Group Discussion		Artifact Analysis	
	Suit.	Adopted	Suit.	Adopted	Suit.	Adopted	Suit.	Adopted	Suit.	Adopted	Suit.	Adopted	Suit.	Adopted	Suit.	Adopted
Introduced Product, Process (Artifact)	●	☑	◐	☑	●	□	○	☑	●	☑	●	□	●	☑	◐	☑
People's Behavior (during workshop)	●	☑	◐	☑	●	□	○	☑	○	□	◐	□	◐	□	○	□
People's Dialogues (during workshop)	◐	□	○	☑	●	□	●	☑	○	□	○	□	◐	□	○	□
People's Interactions (during workshop)	●	☑	◐	☑	●	□	○	☑	○	□	◐	□	◐	☑	○	□
People's Perception and Feelings	○	☑	○	□	◐	□	◐	☑	●	□	●	□	●	□	○	□
People's Opinion and Ideas	○	☑	○	□	◐	□	◐	☑	●	□	●	□	●	☑	◐	☑
Workshop Agenda and Timing	●	☑	○	□	◐	□	○	☑	◐	□	●	□	●	□	◐	□
Workshop Equipment, Furniture, Space	●	☑	◐	☑	●	□	○	☑	◐	□	◐	□	●	□	◐	□
Workshop Materials, Tools, Templates	●	☑	●	☑	●	□	○	☑	●	□	●	□	●	☑	●	☑
Workshop Outcome Quality (e.g., Ideas, Strategy)	◐	☑	○	☑	◐	□	○	☑	●	□	●	□	●	☑	●	☑

○= low suitability ◐= medium suitability ●= good suitability

6 Discussion and Key Lessons Learned

The design and implementation of the cross-disciplinary co-creation workshop provided important insights into both the opportunities and challenges of structured collaboration across domains. While cross-disciplinary settings are often praised for their innovation potential, our experience confirms that such potential does not emerge automatically from diversity alone. Rather, it requires careful orchestration of preparatory conditions, structured interaction formats, and deliberate facilitation strategies. The three-layer model proved valuable precisely because it made these enabling conditions explicit and actionable.

Intentional participant selection emerged as one of the most critical and demanding aspects of the workshop design. Identifying the right participants was a time-intensive process that extended far beyond compiling a contact list. We systematically mapped similar projects across Ireland and Europe, reviewed dozens of scientific publications to identify leading contributors in the field, and actively participated in webinars, workshops, and conferences to engage with relevant communities. This extensive scouting process was complemented by recommendations from trusted collaborators, ensuring both credibility and complementary expertise.

The outcome was a carefully curated pool of participants representing diverse disciplinary backgrounds, institutional affiliations, and practical experiences, all connected by a shared interest in the topic. This diversity significantly enriched the discussions, broadening the range of perspectives and deepening the quality of insights generated. However, our experience also confirmed that diversity alone is not sufficient. Without deliberate structuring and thoughtful grouping strategies, cross-disciplinary richness can quickly turn into fragmentation. Purposeful alignment of expertise and thematic interests was therefore essential to transforming diversity into productive collaboration rather than parallel monologues.

A second key lesson concerns the pivotal role of facilitation and purposeful artefact generation, as well as the structured interaction built around them. The co-creation sessions were most effective when participants were encouraged to externalise their thinking through tangible artefacts, visualisations, and carefully designed templates. These artefacts functioned as boundary objects, enabling participants to negotiate meaning across disciplinary vocabularies, reconcile differing assumptions, and progressively construct shared understanding. In this sense, facilitation strategies and material preparation were not merely logistical considerations, but foundational design decisions that directly shaped the depth and quality of engagement. For example, the deliberate use of different coloured post-it notes was not a cosmetic choice, but a strategic design decision embedded in the facilitation process. Each colour carried a distinct meaning: one represented knowledge generated within a specific group, while another captured insights acquired from cross-group interactions. This simple yet powerful visual coding mechanism enabled participants to immediately distinguish between internally developed ideas and externally informed perspectives. As a result, knowledge flows became visible, traceable, and analysable, reinforcing collective awareness of how ideas evolved and how cross-disciplinary exchange enriched the overall outcomes.

The richness of interaction was particularly evident in the extensive discussions generated during the workshop. Across tables of six to eight participants, conversations unfolded simultaneously and dynamically, resulting in over five hours of recorded dialogue. These exchanges captured spontaneous idea development, critical reflection, disagreement, convergence, and collaborative sense-making in real time. This depth of discussion represents one of the most valuable outputs of the workshop. Beyond producing tangible artefacts, the workshop generated a dense and analytically rich corpus of cross-disciplinary discourse, which is central to fulfilling the methodological and empirical requirements of the case study presented in this research [17]

A third insight concerns evaluation as an embedded rather than retrospective activity. By integrating evaluation planning into the workshop design phase and aligning it with clearly defined goals, we enhanced both methodological rigour and analytical depth. The use of multiple complementary data collection methods strengthened triangulation and increased confidence in the findings. Importantly, systematic reflection after the workshop generated concrete improvements for future iterations, reinforcing the iterative nature of the proposed model.

Finally, we observed that psychological safety and clarity of purpose are foundational to effective cross-disciplinary collaboration. Participants engaged more openly and constructively when expectations were transparent, roles were clearly defined, and the overall objective was consistently communicated throughout the workshop. This underscores that successful co-creation is as much about social and organisational design as it is about intellectual exchange.

Collectively, these lessons highlight that cross-disciplinary co-creation workshops can function as rigorous research instruments when designed systematically. The proposed model not only structures the process but also fosters reflective practice, enabling continuous refinement and adaptation across contexts.

7 Conclusions

In this paper, we presented the systematic design and implementation of a cross-disciplinary co-creation workshop, demonstrating how methodological rigour can be embedded into inherently collaborative and interactive settings. Beyond organising a single successful event, our primary contribution lies in the development of a structured and transferable model for designing and evaluating cross-disciplinary co-creation workshops.

The model introduced in this work consists of three interconnected layers. The first layer focuses on preparatory and contextual elements, including the articulation of a well-defined overarching goal, the careful identification and targeting of participants, ethical considerations, and the logistical conditions required to enable meaningful interaction. By explicitly incorporating these elements, the model recognises that effective co-creation begins well before the workshop itself.

The second layer addresses workshop design and execution. This includes the formulation of clear and measurable objectives, the careful sequencing of sessions, and the development of well-planned, transparent, and engaging co-creation activities. Particular emphasis is placed on balancing informational components with hands-on

collaborative sessions, ensuring that participants not only share knowledge but actively construct artefacts and solutions together.

The third layer concerns systematic evaluation. Here, the workshop is treated not merely as an event but as a research instrument. Evaluation is guided by a robust Goal–Method framework proposed in [6], ensuring alignment between workshop objectives, data collection strategies, and analytical procedures. By integrating evaluation into the model itself, we strengthen the validity, transparency, and reproducibility of cross-disciplinary co-creation initiatives.

Taken together, the proposed three-layer model provides both conceptual clarity and practical guidance. It supports researchers and practitioners in designing workshops that are not only engaging and collaborative, but also methodologically sound and evaluable. The model is transferable across domains and can be iteratively refined, contributing to the maturation of workshops as credible and rigorous research methods in cross-disciplinary contexts.

Ethics Declaration

Ethics declaration: not applicable.

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